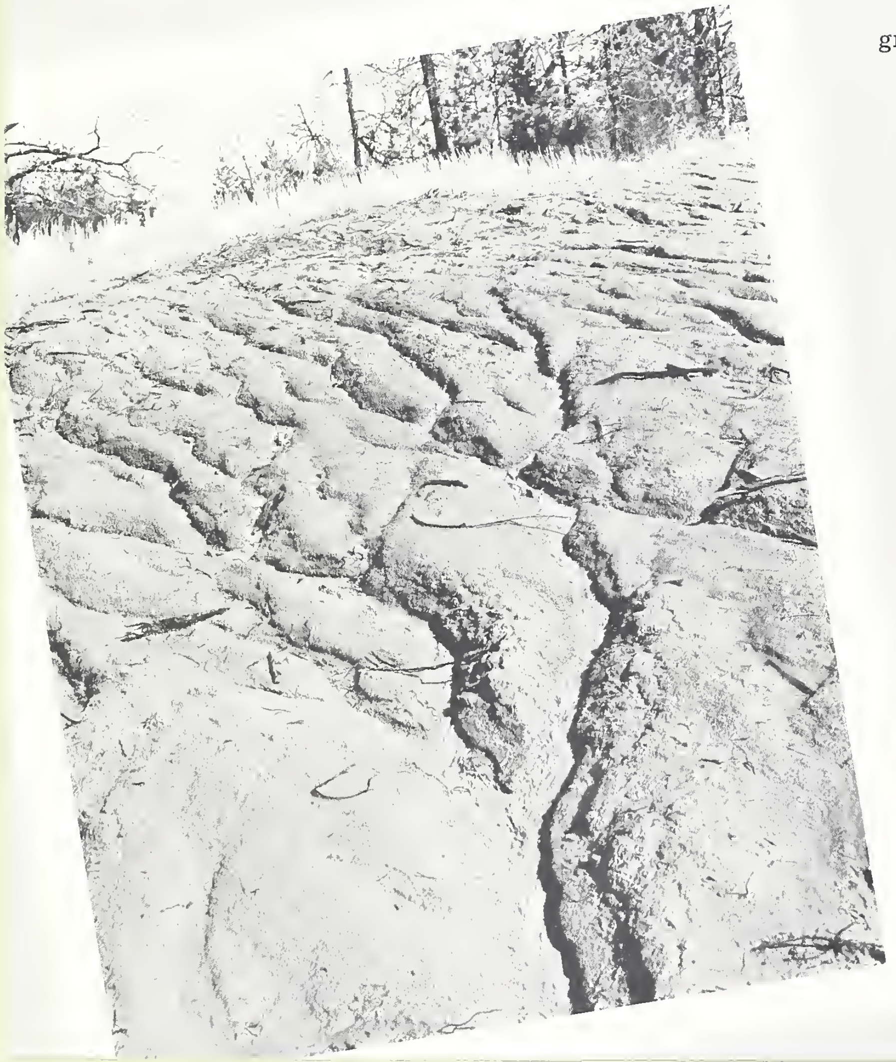
RESEARCH TO TAME THE RAIN

WATERSHED MANAGEMENT RESEARCH at the SOUTHERN FOREST EXPERIMENT STATION

1964

RESEARCH TO TAME THE RAIN

George K. Stephenson



Good watersheds mean useful water. Filtered through spongy ground cover and porous soil, rain feeds gradually into streams and ground water. Surplus rain is held back to keep streams flowing in dry weather, or percolated down to maintain supplies for wells.

Rain that falls on bare, hard ground has little chance to soak into the soil. A large proportion runs off over the surface, eroding the topsoil, cutting gullies, and causing floods.

The Midsouth has more than 4 feet of precipitation in the average year. Well-managed watersheds can convert most of this into useful water for agriculture and forestry, for industry, domestic needs, irrigation, and recreation. When watersheds are in poor condition, a large part goes to waste, producing floods, erosion, and damage to valley lands.

Nearly two-thirds of all southern watersheds are in forests. Research must learn how these lands can be managed so as to contribute most to meeting southern water needs.

82391

The deep mulch layer under a good stand of trees stops erosion and filters rainfall into soil layers where it nourishes plants and replenishes ground water and streamflow.

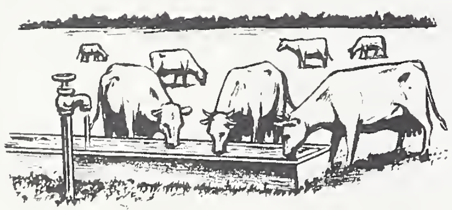
Dependable flows of clear water from watersheds protected by forest cover are needed for irrigation, domestic use, and industry.

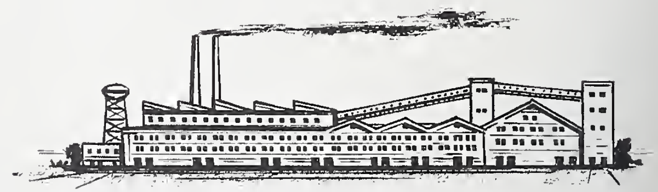
Water Needs Grow

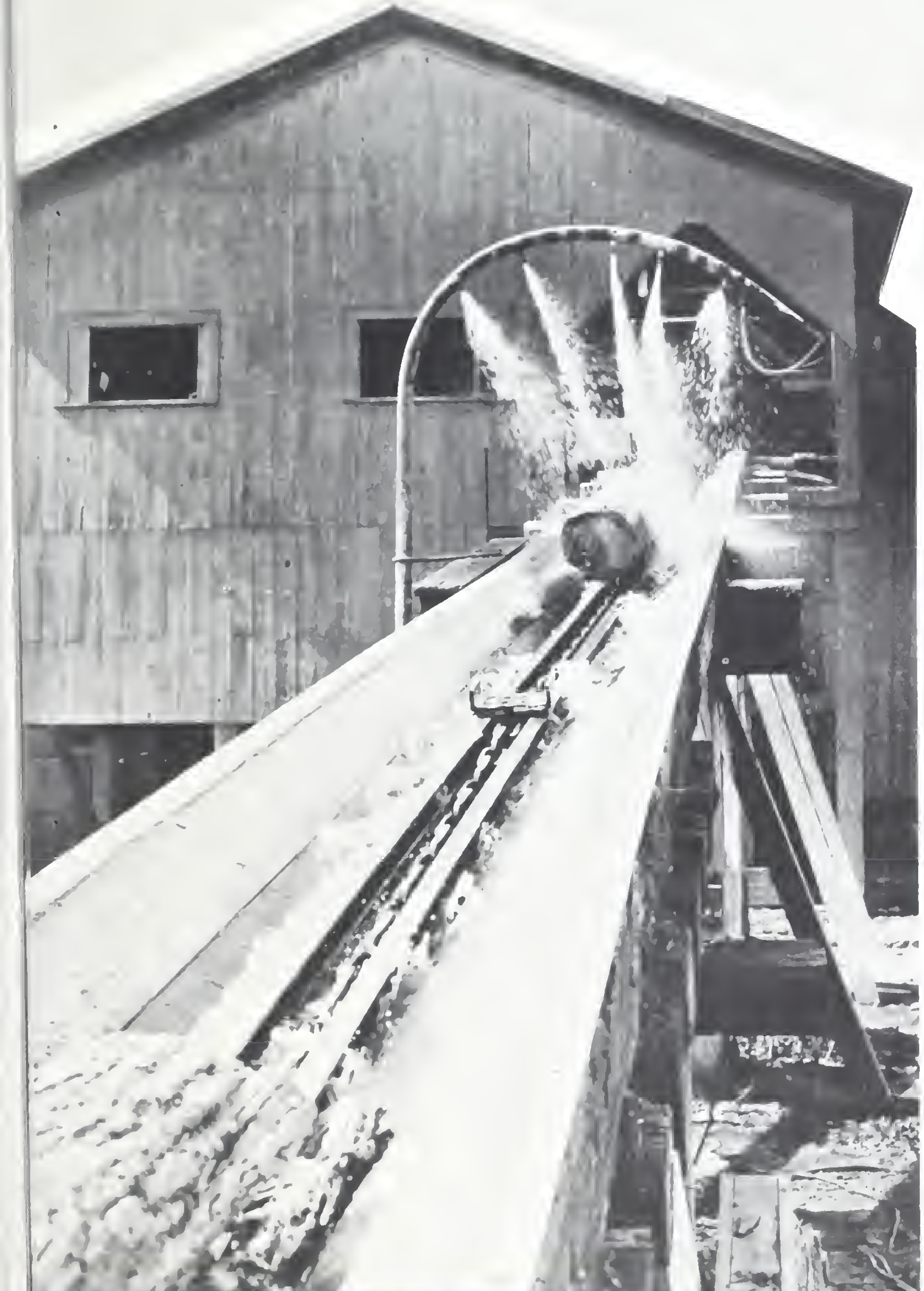
Industries come south, cities enlarge, people move to town, and their needs for water change. Domestic needs go up—for washing machines, to sprinkle lawns, to cool buildings. Even greater are the needs of industries, for cooling, for processing, and for waste disposal. Clean water the year around, and plenty of it, is essential to progress in a growing South. Except as supplied by the Mississippi River, it must come from streams or ground water, fed by southern rainfall.

New water uses bring problems. Deep wells must be drilled to tap artesian water where shallow wells were adequate for rural use. But growing cities and expanding industries overtax even the bountiful artesian supplies. To meet heavy demands for industry, still deeper sources must be tapped, or new well fields developed. Irrigation, especially of rice, now is often limited by the capacity of underground supplies. More and more it is necessary to impound surface water to meet concentrated needs.

Whatever source is developed, it can only be replenished by rainfall. How much of the rain enters the soil, how much is recharged into ground water, how much is stored for summer streamflow, and the quality of water available for impoundment—all depend upon watershed conditions.







Water for irrigation,

. . . for industry,

. . . for growing cities

must come from southern watersheds.

Why Watershed Research?

Watershed scientists, like those in other fields, have made great progress in recent years. They have learned some of the general principles that influence water supplies. They can provide sound general guides to desirable watershed conditions, and in special cases can make fair estimates of results to be expected.

But forests and soils and watersheds are far from simple; weather patterns differ, water needs and objectives vary, and competing land uses call for compromises. To provide optimum conditions for particular objectives on specific watersheds, managers need and research must provide detailed information on many phases of water behavior, and on the influence of many factors that may occur on individual areas.

As an example, it has been shown that the litter and humus under stands of trees reduce surface runoff and erosion, and increase the proportion of rainfall soaking into the ground.

But much more needs to be known about how this process is affected by different soils, how deep a litter layer is needed, or what kinds of stands provide the best cover.

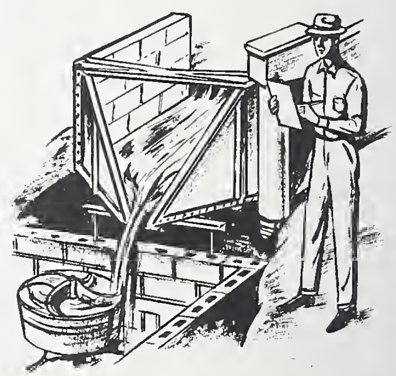
Again, trees use some of the water that enters the ground. Land managers need to know how much is used by different kinds of stands, what soil layers it comes from, when this use occurs, and how it affects percolation to water tables that supply streamflow and ground water.

Water that enters the ground through forest covers is stored in deeper layers of soil. How much is stored, and for how long? How are storage and water movement affected by types of soil? What governs water movement through different kinds of soil layers?

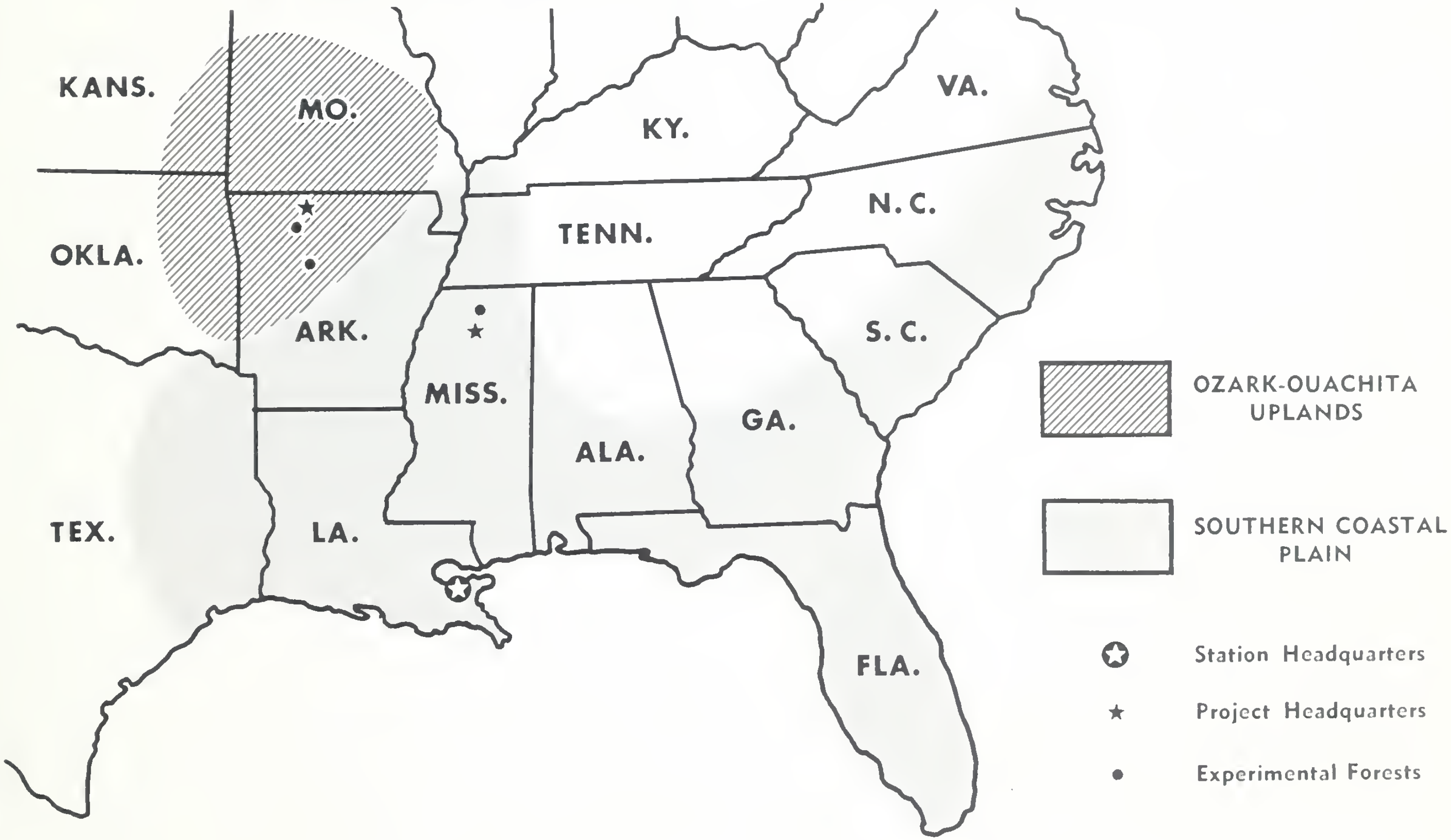
Such questions, and many others, must be answered if southern watersheds are to contribute fully to southern water needs.

How much litter is needed to stop erosion? Would more be required for a steeper slope or a sandier soil?

What controls the rate of seepage into deep soil layers? Can tree roots open channels for faster water movement?



Research Locations



To provide the scientific knowledge required to manage southern watersheds for optimum use of rainfall, the Southern Forest Experiment Station conducts four research projects in watershed management. One project, at Harrison, Arkansas, studies water relations and streamflow in the Ozark-Ouachita uplands; three others, at Oxford, Mississippi, study problems of the southern Coastal Plain.

Ozark-Ouachita Mountains

Fewer Floods, More Summer Streamflow

Shallow soils make mountain watersheds sensitive to rainfall extremes. Moisture reserves fail in long droughts, and streams go dry; heavy storms cause floods because there is too little soil to store them. Yet, on most streams, in most seasons, flow depends on the kind of forest on the watersheds, and how well the forest floor absorbs rainfall for storage in the soil.

Research is under way to—

Study the depth and character of mountain soils, the rate at which they take in and transmit water, and the amounts they can hold.

Determine how tree roots and surface litter influence absorption and storage rates, and how they control erosion.

Find how fast trees use water from the soil, and how much the rate changes as old trees are cut and young stands grow.

Test cutting methods designed for desirable effects on streamflow.

Researchers study the rate of growth of seedlings on shallow, rocky sites, to learn how soon they can produce enough litter to slow storm runoff.

Studies measure rainfall caught by tree foliage and the amounts which run down their stems.

On study watersheds, flumes are installed to record the flow of runoff. The wheel samples the sediment load.

From this work will come guides for managing the timbered watersheds of the Ozarks and Ouachitas to minimize flooding and to deliver maximum useful streamflow for the development of industry and recreation.

Headquarters for research on this problem are at Harrison, Arkansas. Field studies are on the Alum Creek Experimental Forest near Hot Springs, on the Koen Experimental Forest south of Harrison, and on plots located as needed throughout the mountain areas.

Ground Water and Streamflow in the Coastal Plain

Beneath the Coastal Plain from Virginia to Texas lie deep sedimentary deposits with immense water storage capacity. Through their upper layers flow the waters that replenish deep ground-water supplies and maintain dry-weather flows in streams. Watershed cover determines whether rainfall enters the soil to recharge these strata or runs off as damaging floodwater. The condition of the watershed, therefore, may profoundly influence water supplies, both surface and underground.

Research must discover how water enters the soil, where and how it moves to streams and water-bearing strata, and what kinds of forests deliver the most useable water.

Questions like these must be answered:

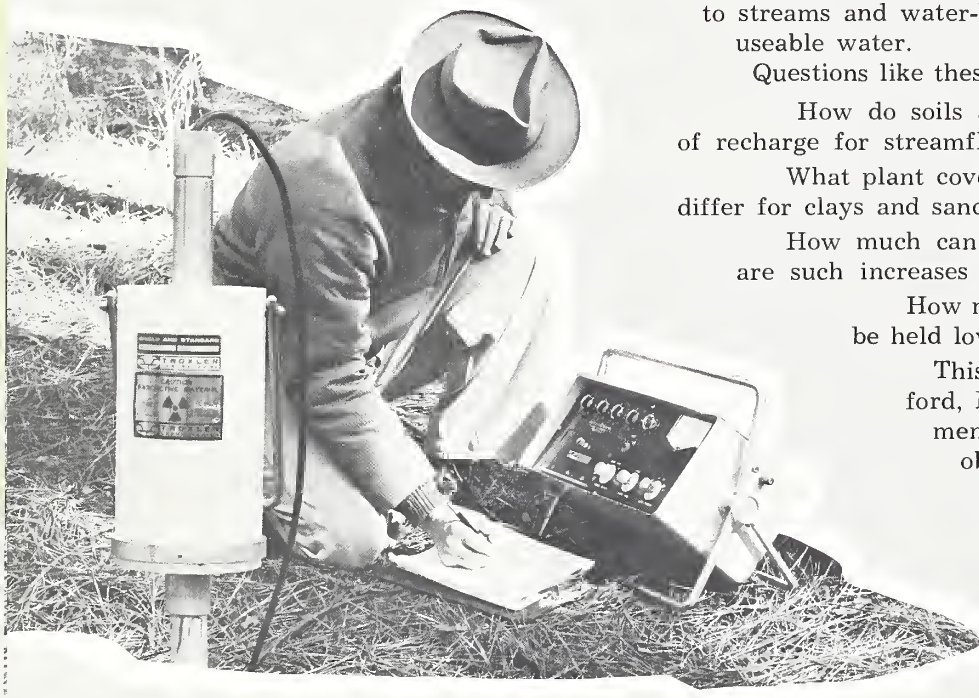
How do soils and geology affect ground water? Where are the areas of recharge for streamflow and ground-water reservoirs?

What plant covers seep the most rainfall into the soil? How do effects differ for clays and sands?

How much can soil permeability be increased by forest growth? Where are such increases needed, and how can they be fostered?

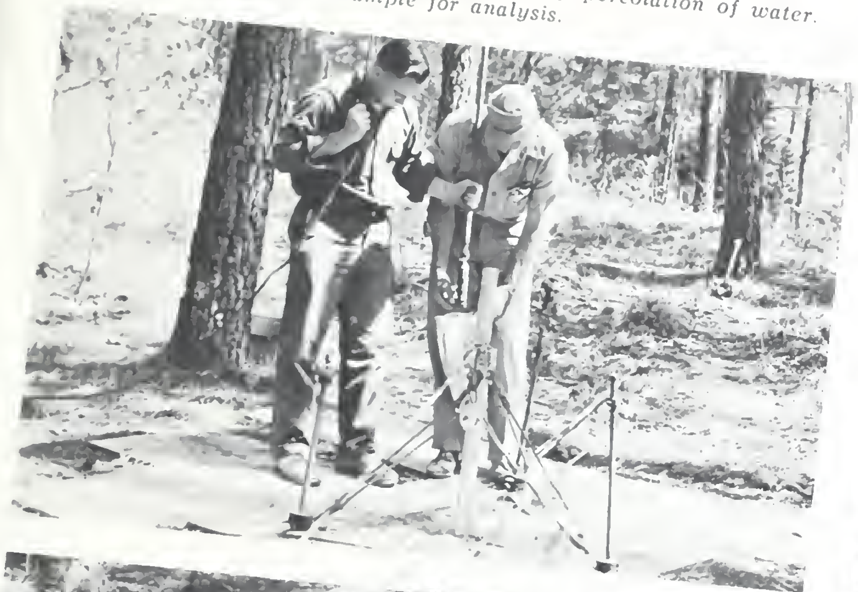
How much soil moisture do trees require? How can the amount be held low, to leave more for other purposes?

This southwide project has its research headquarters at Oxford, Mississippi. There the physical processes of water movement through soils are studied in the laboratory. Five years' observations on 12 gaged watersheds have revealed much about the effects of forest cover and soil characteristics on absorption of rainfall. As the cover is altered by cutting, planting, and other treatments, observations will continue to measure changes in runoff and in seepage to ground-water layers. Other studies throughout the Coastal Plain will provide information on where and how forests can be managed to improve water supplies.



Scientist records radiation reflected by moisture from radioactive probe. Lowered into permanent access tubes, this device measures moisture in deep soil layers.

Installing access tube for measuring deep percolation of water. Scientist collects soil sample for analysis.



Comparison of rainfall beneath trees with that in the open estimates amount intercepted by tree crowns.

Pipe with openings in lower part serves as a well to measure changes in ground water levels.

Runoff from experimental watershed is recorded continuously. A test burn greatly increased erosion from this area.

Trees to Control Erosion

Soil washing from eroding farmlands muddies streams, clogs drainageways, and buries fertile bottoms. This damage can be stopped, along with the loss of upland soil, by an adequate tree cover. Research has found ways to plant gullied lands; in north Mississippi alone, half a million acres have been planted.

Still the job is far from complete. Cheaper, surer ways are needed to get trees started. On the worst eroded sites, too many trees still die. Too many years elapse before the best tree plantings become effective.

Research must learn more about eroded sites and how they affect plant growth. Ways must be found to grow cover on dry sands and to keep plants growing where hard subsoils are exposed. New plants must be found to hold the soil until trees are big enough to spread a litter blanket.

Research on these subjects is under way at Oxford, Mississippi, where some of the most eroded soils in the South are available. Studies include detailed analysis of the characteristics of soils on adverse sites, measurement of site changes after erosion-control planting, and survival and effectiveness of plants used to supplement trees. In the planning stage are basic studies of factors that limit root growth and development of trees and other erosion-control plants. From these should come further improvements in erosion control.

A

B

C

A *Where pines can grow, they produce a mulch which halts erosion.*

B *Some sites erode so fast that trees are lost. Others are too hard or dry for trees to survive.*

C *Foresters have learned to recognize favorable planting spots. They use brush dams to form more spots where trees will grow. But quicker control is often needed.*

D,E *Sampling soils and testing them in the laboratory are first steps toward faster erosion control through better tree planting and supplemental vegetation.*

D

E

Managing Timber on Erosive Sites

When stabilized with pines, erosive sites can be productive. Young trees will grow into pulpwood, poles, and eventually saw logs. Harvested, such forest crops may bring the first income in decades from once worthless land.

The question is, How can these crops be harvested without starting a new erosion cycle or disturbing satisfactory water flows?

This is the third project of the watershed research group at Oxford, Mississippi.

To guide landowners in the safe removal of products, and best long-term use of these lands, researchers will try to determine:

How partial cutting affects the accumulation of protective litter and the growth of stands.

How to prevent soil washing in logging roads and skid trails.

How to reproduce stands without exposing soil to excessive erosion.

Whether prescribed burning is feasible in managing timber on erosive sites.

Whether forage can be grazed without damage to such sites.

How much soil is lost from logging roads? How can this be minimized?

Litter keeps the soil in place. How much is it reduced when part of the stand is cut?

Automatic gage records runoff and samples sediment from a watershed stabilized by 20-year-old pines. Part of the stand will be cut to test effects on streamflow and erosion.

Plots on the Tallahatchie Experimental Forest near Oxford, and also on lands of cooperators, are being used to study effects of several types of forest management on timber growth and watershed cover. Plots and small gaged watersheds on the Holly Springs National Forest near Coffeeville are furnishing information on how timber-cutting practices affect litter accumulation, runoff, and erosion. Studies on logging operations will measure erosion caused by logging, and develop safe methods for erosive areas. Observations on grazing and burning are being made as a basis for later studies of these problems.

SOUTHERN FOREST EXPERIMENT STATION
Forest Service, U. S. Department of Agriculture